CLAIMS

1. A manufacturing method of a semiconductor module comprising:

a first joining step for joining first circuit electrodes which are formed on a circuit board and back-surface-side die electrodes of a semiconductor die which forms die electrodes on both front and back surfaces;

a second joining step for joining the front-surface-side die electrodes of the semiconductor die and one ends of linear or plate-like connecting members; and

a third joining step for joining another ends of the connecting members and second circuit electrodes which are formed on the circuit board, wherein

in at least one of the first joining step, the second joining step and the third joining step, a low-melting-point metal layer is preliminarily formed on at least one of a pair of conductive portions to be connected with each other and, thereafter, the pair of conductive portions are arranged to face each other and are heated and pressurized at a temperature which melts at least the low-melting-point metal thus diffusing the low-melting-point metal layer into the pair of conductive portions by solid-liquid diffusion whereby the pair of conductive portions are joined to each other.

2. A manufacturing method of a semiconductor device

comprising:

a first joining step for joining first circuit electrodes which are formed on a circuit board and back-surface-side die electrodes of a semiconductor die which forms die electrodes on both front and back surfaces;

a second joining step for joining the front-surface-side die electrodes of the semiconductor die and one ends of linear or plate-like connecting members;

a third joining step for joining another ends of the connecting members and second circuit electrodes which are formed on the circuit board; and

a fourth joining step for joining a third circuit electrode formed on the circuit board and a heat radiating member made of metal wherein

in at least one of the first joining step, the second joining step and the third joining step and the fourth joining step, a low-melting-point metal layer is preliminarily formed on at least one of a pair of conductive portions to be connected with each other and, thereafter, the pair of conductive portions are arranged to face each other and are heated and pressurized at a temperature which melts at least the low-melting-point metal thus diffusing the low-melting-point metal layer into the pair of conductive portions by solid-liquid diffusion whereby the pair of conductive portions are joined to each other.

3. A manufacturing method of a semiconductor module

according to claim 1 or 2, wherein the low-melting-point metal layer is formed on at least one of the pair of conductive portions, a metal foil is interposed between the pair of conductive portions, and the pair of conductive portions are heated and pressurized.

4. A manufacturing method of a semiconductor module comprising:

a first joining step for joining first circuit electrodes which are formed on a circuit board and back-surface-side die electrodes of a semiconductor die which forms die electrodes on both front and back surfaces;

a second joining step for joining the front-surface-side die electrodes of the semiconductor die and one ends of linear or plate-like connecting members; and

a third joining step for joining another ends of the connecting members and second circuit electrodes which are formed on the circuit board, wherein

in at least one of the first joining step, the second joining step and the third joining step, a low-melting-point metal layer is preliminarily formed on at least one surface or both surfaces of a metal foil, and, thereafter, the pair of conductive portions to be connected are arranged to face each other, the metal foil is interposed between the pair of conductive portions, the pair of conductive portions are heated and pressurized at a temperature which melts at least the

low-melting-point metal thus diffusing the low-melting-point metal layer into the pair of conductive portions by solid-liquid diffusion whereby the pair of conductive portions are joined to each other.

5. A manufacturing method of a semiconductor module comprising:

a first joining step for joining first circuit electrodes which are formed on a circuit board and back-surface-side die electrodes of a semiconductor die which forms die electrodes on both front and back surfaces;

a second joining step for joining the front-surface-side die electrodes of the semiconductor die and one ends of linear or plate-like connecting members;

a third joining step for joining another ends of the connecting members and second circuit electrodes which are formed on the circuit board; and

a fourth joining step for joining a third circuit electrode formed on the circuit board and a heat radiating member made of metal wherein

in at least one of the first joining step, the second joining step and the third joining step and the fourth joining step, a low-melting-point metal layer is preliminarily formed on at least one surface or both surfaces of a metal foil, and, thereafter, the pair of conductive portions to be connected are arranged to face each other, the metal foil is interposed

between the pair of conductive portions, the pair of conductive portions are heated and pressurized at a temperature which melts at least the low-melting-point metal thus diffusing the low-melting-point metal layer into the pair of conductive portions by solid-liquid diffusion whereby the pair of conductive portions are joined to each other.

6. A manufacturing method of a semiconductor module according to any one of claims 1 to 5, wherein the low-melting-point metal layer contains at least one selected from a group consisting of SnIn, In, Bi, SnBi.

7. A manufacturing method of a semiconductor module according to claim 6, wherein a heating temperature at the time of the joining is a temperature which is 0 to 100°C higher than the melting point of the low-melting-point metal.

8. A manufacturing method of a semiconductor module according to any one of claims 1 to 7, wherein a total thickness of the low-melting-point metal layer which is formed preliminarily between the pair of conductive portions assumes a value which falls within a range from 0.1 to 1 μm.

9. A manufacturing method of a semiconductor module according to any one of claims 1 to 8, wherein a material of the pair of conductive portions is one selected from a group consisting of Cu, Ni, Au, Al or alloy thereof.

10. A manufacturing method of a semiconductor module according to any one of claims 1 to 9, wherein the

heating-and-pressurizing is performed until the low-melting-point metal layer is completely diffused in the pair of conductive portions by solid-liquid diffusion.

11. A manufacturing method of a semiconductor module according to any one of claims 1 to 9, wherein the heating-and-pressurizing is performed until the low-melting-point metal layer forms an intermediate alloy layer between the pair of conductive portions.

12. A manufacturing method of a semiconductor module according to any one of claims 1 to 11, wherein the connection member is a lead frame.

13. A manufacturing method of a semiconductor module according to any one of claims 1 to 12, wherein the surfaces of the pair of conductive portions are formed of coarse surfaces having the surface roughness Ra of 0.4 to 10 μm.

14. A manufacturing method of a semiconductor module according to any one of claims 1 to 13, wherein the low-melting-point metal layer is formed such that at least two kinds of metals which can form alloy are stacked in two layers or more, and the stacked metal layers are preheated to make the metal layers react with each other to form an alloy layer.

15. A manufacturing method of a semiconductor module according to any one of claims 1 to 13, wherein the low-melting-point metal layer is formed by vapor-depositing alloy which constitutes an evaporation source and, at the time

of performing the vapor deposition, an evaporation pressure ratio in reaction steps of respective metal components of the alloy is controlled thus forming a film having the target alloy composition.

16. A manufacturing method of a semiconductor module according to any one of claims 1 to 13, wherein the low-melting-point metal layer is formed by vapor-depositing alloy which constitutes an evaporation source and, at the time of performing the vapor deposition, a product of an evaporation pressure ratio and an active coefficient ratio in reaction steps of respective metal components of the alloy is controlled thus forming a film having the target alloy composition.